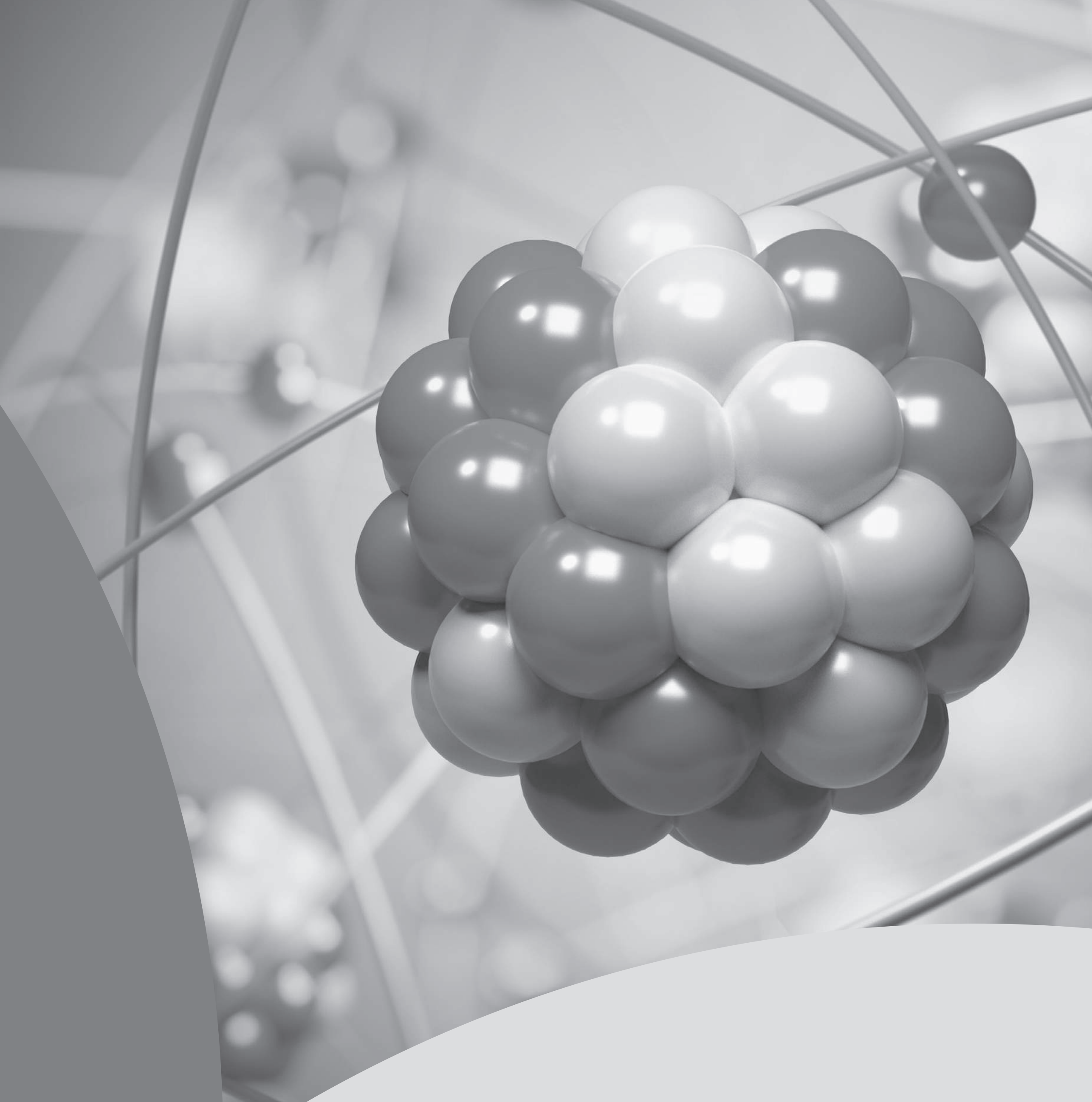


مفاهيم الفيزياء (إنجليزي)

الصف الثالث الثانوي

Unit One: Dynamic electricity and magnetism

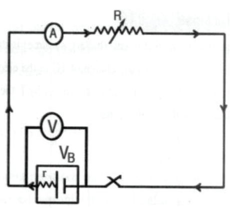
Chapter One: electric current and ohm's law and Kirchhoff's laws

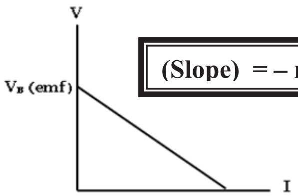
Concepts

1- The electric current is the amount of charge flowing through a conductor.
2- Electric current intensity (I) is the amount of electric charges flowing through a given section of a conductor in a time of 1 s
3- The potential difference between two points (V) is the work done in joules to transfer a unit of electric charge (1coulomb) from one point to another.
4- The electromotive force of a source (V_B) is the total work done required to transfer a unit charge (1coulomb) through the whole circuit (outside and inside the source) and has the same measuring unit of potential difference (volt).
5- The electric resistance (R) is the opposition of the conductor to flow the electric current, it depends at constant temperature on the length of the conductor , its cross-sectional area and the type of its material
6- The specific resistance of the material (the electric resistivity) (ρ_e): (It is the resistance of a conductor of length 1m and of cross sectional area $1m^2$ at constant temperature). It depends on the temperature and the type of conductor material.
7- The electric conductivity of a material (σ) (is the reciprocal of the specific resistance). it depends on the temperature and the type of conductor material
8- **Ohm's Law**:(The current intensity flowing through a conductor is directly proportional to the potential difference across its ends at constant temperature)
9- Ohm's Law for closed circuit **(the electric current intensity in a closed circuit is the emf of the total source divided by the total resistance of the circuit**.

10- The relation between the electromotive force of a cell (V_B) and the potential difference between its poles (V)

(The electromotive force of a cell is the voltage difference across the cell (source) when the current vanishes to flow in the circuit).





(Slope) = – r

11- Kirchhoff's laws

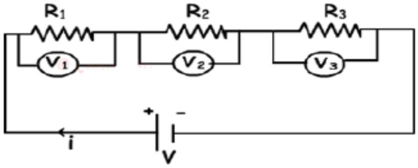
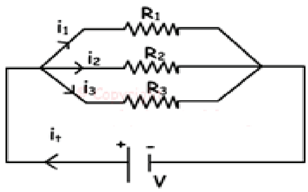
1- (At any node (junction) in an electrical circuit, the sum of currents flowing into the node is equal to the sum of currents flowing out of that node)(**based on** conservation of electric charge)

$\sum I_{in} = \sum I_{out}$ (KCL)

2- (The algebraic sum of the electromotive forces in any closed loop is equivalent to the algebraic sum of potential differences within that loop) (based on conservation of energy)

$\sum V_B = \sum I R$ (KVL)

12- Connection of resistors:

	Series connection	**Parallel connection**
1		
2	The current through all the resistors is the same $I = I_1 = I_2 = I_3$	The total current flowing through the circuit is equal to the sum of the currents passing through each individual resistance $I = I_1 + I_2 + I_3$
3	The total potential difference between the two ends of the group is equal to the sum of the potential differences on the resistors in the circuit $V = V_1 + V_2 + V_3$	The potentiel difference through all the resistors is the same $V = V_1 = V_2 = V_3$
4	The equivalent resistance R' **of a group** of resistors connected in series is equal to the sum of these resistors $R^{\backslash} = R_1 + R_2 + R_3$ If there are (N) equal resistances connected in series each equal to (R) $R^{\backslash} = N R$	The reciprocals of equivalent resistance R' **of a group** of resistors connected in parallel is equal to the sum of the reciprocals of these resistors $R^{\backslash} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$ If there are (N) equal resistances connected in parallel each equal to (R) $R^{\backslash} = \frac{R}{N}$ For two resistors: $R` = \frac{R_1 . R_2}{R_1 + R_2}$

The laws and the mathematical relations

1	$I = \frac{Q}{t} = \frac{N.e}{t}$	I : current intensity(ampere) t : time of flow(second) Q: the quantity of charges(the total number of electrons passing a given point) (coloumb) N: No. of eleectrons E: charge of electron = 1.6×10^{-19} C
2	$V = \frac{W}{Q}$	**V** : potential difference between two points (volt) **W** : the work done (Joule)
3	$R = \frac{\rho_e L}{A}$	L: is the length of the conductor (m) A: is its cross-sectional area in(m^2), ρ_e: is the specific resistance(Ω.m)
4	**V = I R**	V: is the potential difference between the ends of the conductor I :is the current through the conductor R :is the resistance of the conductor
5	**Ohm's Law for closed circuit** $V_B = I(R^\backslash + r)$ $I = \frac{V_B}{R^\backslash + r}$	V_B: the electromotive force of the cell (battery) I :the total current in the circuit **R**\\:the external (equivalent) resistance r: the internal resistance of the cell
6	The relation between the electromotive force of a cell (V_B) and the potential difference between its poles (V): $V = V_B - Ir$	V_B: the electromotive force of the cell (battery) I :the total current in the circuit V:the terminal voltage (potential difference between terminals of the cell r: the internal resistance of the cell
7	$P_w = \frac{W}{t} = V \cdot I = I^2 \cdot R = \frac{V^2}{R}$	**P_w:** the consumed power by the conductor
8	$P_w = V_B \cdot I$	**P_w:** the produced power by the battery

Chapter two

The magnetic effect of electric current

Concepts

1- Magnetic field due to a current in a straight wire:

a) The shape of the magnetic field

They are arranged in the form of concentric uniform circles.

As the intensity of the electric current in the wire increases, **the concentric circles more crowded (**the circular magnetic flux lines are **closer together)** the lines of flux around the wire increase.

b) The direction of the magnetic field can be determined by using Ampere right-hand rule

2- Magnetic field due to a current in a circular coil.

a) The shape of the magnetic field

The magnetic field produced due to current passing through the circular coil , is very similar to that of a short bar magnet(a circular disk) .The flux lines become straight and parallel lines perpendicular to the plane of the coil at the center of the coil. This means that the magnetic field in this region is uniform.

b) The direction of the magnetic field can be determined by using the right-hand screw rule

3- Magnetic field due to a current in a solenoid.

a) The shape of the magnetic field

The magnetic field produced by a current carrying solenoid is similar to the magnetic field produced by a bar magnet

The lines of magnetic flux through the middle of the solenoid (In a solenoid) are straight and parallel to the axis, so the magnetic field is uniform

b) The direction of the magnetic field can be determined by using Ampere right-hand rule or the right-hand screw rule

4- Neutral point :**(it is the point at which the total magnetic flux density vanishes)**

5- Force due to magnetic field acting on straight wire carrying current placed in a uniform magnetic field depends on

a) Length of the wire where.
b) Current intensity passing through the wire where
c) Magnetic flux density where.
d) The angle (θ) between the direction of the external magnetic field and the direction of the length of the conductor

6- The mutual force between two parallel wires, each carrying an electric current, is attractive force when the two currents are in the same direction and repulsive force when the two currents are in opposite directions.

7- The magnetic torque acting on a coil carrying an electric current placed in a uniform magnetic field depends on:

a) the area of the coil's plane
b) the electric current intensity
c) magnetic flux density which the coil is placed inside it
d) number of turns of the coil
e) the angle between perpendicular to coil's plane and the magnetic flux lines (magnetic dipole moment)

8- The sensitive moving coil galvanometer used to Measure the weak DC electric current and determine the direction of current flow, it depends on the magnetic torque that is generated on a coil carrying current placed in a magnetic field

9- The galvanometer sensitivity:

It is the scale deflection from the zero position per unit current intensity passing through the coil

10- DC ammeter Used to measure the current intensity

a) depends on the magnetic torque that is generated on a coil carrying current placed in a magnetic field
b) Ammeter is a device that is used after calibrating its scale to measure the intensity of the current passing through its circuit directly. A moving coil galvanometer can be thought of as an ammeter but is limited by the sensitivity of its moving coil. In order to increase the range of the galvanometer, it is necessary to add a very small resistance called a shunt resistance R_S connected in parallel with the coil of the galvanometer R_g.

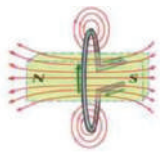
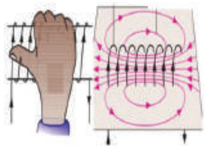
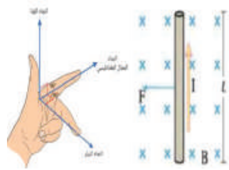
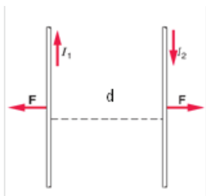
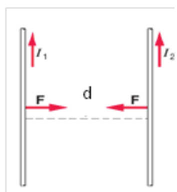
11- DC Voltmeter Used to measure the potential difference between two points

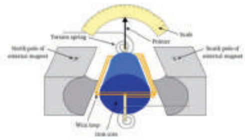
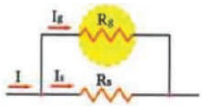
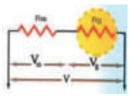
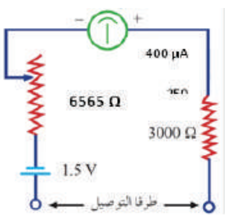
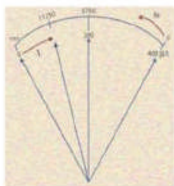
a) depends on the magnetic torque that is generated on a coil carrying current placed in a magnetic field
b) A voltmeter is a device used after calibrating its scale to measure the potential differences (voltage) across two points. Therefore, it is necessary to add a very large resistance called the multiplier resistance Rm, connected in series with the coil of the galvanometer R_g.

12- Ohmmeter

Used to measure the electric resistance and its operation depends on Ohm's law for closed circuit

The laws and the mathematical relations

1	**Calculating the magnetic flux density at a point from a wire carrying current** $$B = \frac{\mu I}{2\pi d}$$	I : current intensity B is the magnetic flux density at a point d is the vertical distance from the wire μ: magnetic permeability. 
2	**Calculating the magnetic flux density at center of a circular coil carrying current** $$B = \frac{\mu NI}{2r}$$	I : current intensity B is the magnetic flux density at center of the circular coil r is the radius of the circular coil μ: magnetic permeability 
3	**Calculating the magnetic flux density at a point along the axis of a solenoid carrying current** $$B = \frac{\mu NI}{L}$$ $$B = \mu n I$$	I : current intensity B is the magnetic flux density at a point along the axis of a solenoid L is the length of solenoid axis μ: magnetic permeability n:number of turns per unit length 
4	**The magnetic force acting on a straight wire carrying current placed in a uniform magnetic field** $$F = \ell IB \sin\theta$$	F: the magnetic force ℓ: length of the wire I : current intensity B : the magnetic flux density θ: The angle between the direction of the external magnetic field and the direction of the length of the conductor 
5	**The mutual force between two parallel wires each carrying current** $$\frac{F}{L} = \frac{\mu I_1 I_2}{2\pi d}$$	F/L :the magnetic force per unit length I_1,I_2 : the two current through the two parallel wires d: distance between the two parallel wires 

6	**The magnetic torque acting on a coil carrying current placed in a magnetic field:** $\tau = B\,I\,A\,N \sin\theta$ the magnetic torque is measured in N.m.	τ:magnetic torque B : the magnetic flux density I : current intensity N: number of turns θ: The angle between the direction of the external magnetic field and perpendicular to the coil's plane
7	**Magnetic dipole moment** $\lvert m_d \rvert = IAN$	$\lvert m_d \rvert$: magnetic dipole moment I : current intensity N: number of turns A: area of the coil
8	**Sensitivity of the galvanometer (S)** $S = \frac{\theta}{I}$	θ : angle of deflection of the galvanometer pointer I : the current through the coil 
9	**Value of shunt resistance R_S** $R_S = \frac{I_g R_g}{I - I_g}$	R_s: shunt resistance I_g: the maximum current through the galvanometer R_g: resistance of the galvanometer I:the maximum current measured by the ammeter 
10	**Value of multiplier resistance** $\boxed{R_m = \frac{V - V_g}{I_g}}$	R_m: multiplier resistance I_g: the maximum current through the galvanometer V_g: voltage across the galvanometer V:the maximum voltage measured by the voltmeter 
11	**Value of unknown resistance (external) by using ohmmeter** $I_g = \frac{V_B}{R_g + R_v + R_s + r} = \frac{V_B}{R_{device}}$ $I = \frac{V_B}{R_g + R_v + R_S + r + R_X} = \frac{V_B}{R_{device} + R_X}$ 	R_g: resistance of the galvanometer R_V: the value of resistance taken from rheostat R_S: the fixed resistance R_X: unknown resistance I_g: the maximum current through the galvanometer <table><tr><th>$R_x(\Omega)$</th><th>IμA</th></tr><tr><td>0</td><td>400</td></tr><tr><td>3750</td><td>200</td></tr><tr><td>11250</td><td>100</td></tr><tr><td>∞</td><td>0</td></tr></table>

chapter three: Electromagnetic induction

The concepts

1- **Electromagnetic induction:** it is a phenomon an electromotive force are induced in the coil when the magnet flux lines cut the coil when the magnet is plunged into or removed from the coil and also the an electric current induced in close circuit
2- **- The presence of iron core inside the coil concentrates the magnetic flux lines that concentrate magnetic flux lines therefore induced electromotive force and induced electric current are increased**
3- **Faraday's Law of electromagnetic induction:** the induced electromotive force which is generated in a coil by the electromagnetic induction is direct proportional with the time rate by which the coil cut (linked with) the lines of magnetic flux and the number of turns of the coil
4- **Lenz's rule:** the induced current must be in a direction such as to oppose the change producing it.
5- **Fleming's right hand rule:** Form your hand where the pointer and the thumb are perpendicular to each other and both of the perpendicular to the rest of other fingers The pointer is in the direction of the magnetic field The thumb is in the direction of the motion of the wire so The rest of fingers is in the direction of the induced current
6- **Mutual induction:** it is the electromagnetic effect between 2 neighboring or overlapping coils when a current with variable intensity passes through the primary coil so the secondary coil is affected by it and resist the changes happened in the primary coil
7- **Self-induction:** It is the electromagnetic effect induced in the same coil when the intensity of the current increases or decreases. This effect resists the variation in the current intensity.
8- **The coefficient of self-induction(self-inductance) (L):** it is the electromotive force induction generated in a coil due to self-induction when the rate of the current intensity passes through the primary coil of 1 ampere / second
9- **unit of measuring self-induction is Henry:** it is the self-inductance of a coil when electromotive force induction of 1 volt is induced when the rate of the current intensity passes through the coil of 1 ampere / second $\text{Henery (1H)} = \frac{1V.1S}{1A} = \frac{\text{Volt.Second}}{\text{Ampere}}$

10- **The factors in which the self-inductance (L) depends on :**

a. The geometry of the coil
b. The number of turns of the coil
c. The spacing between the turns
d. Magnetic permeability of its core.

11- **Eddy current:** they are induced electric currents circulate in a close path in a thick solid conductor when it is subjected (intercepted) by a variation in magnetic flux linkage by moving a metallic piece in a constant magnetic field or by subjected to a variable magnetic field as the field produced by the AC current

12- Application of Eddy Current: induction furnace for melting metals that induced electric currents flow through the thick solid conductor placed inside a coil carry alternating current by a variation in magnetic flux linkage metallic piece

13- Alternating current generator (Dynamo):device converting the mechanical energy into electrical energy when a coil rotates in magnetic field, it produces Alternating current

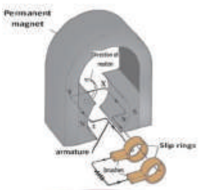
14- structure of simple Electric generator:

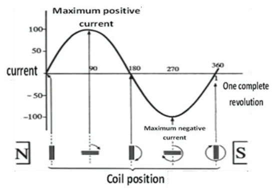
a. **A fixed strong field magnet (permanent or electro-magnet)**

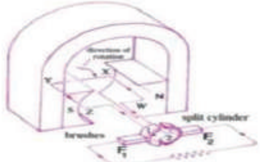
b. **An armature:** it consist of a single loop of a wire or a coil of many turns suspended between the 2 poles of the field magnet

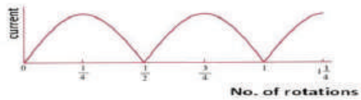
c. **Two slip rings:** they are connected once to each end of the coil and they rotate which the coil in the magnetic field **OR metallic cylinder split into number of insulated segments to generate a nearly direct current**

d. **Two graphite brushes:** the induced currents in the coil pass to the external circuit through them, each of them touches one of the two corresponding slip rings









15- The average e.m.f produced in dynamo coil during one complete cycle equal zero. The consumed energy during an alternating current in Ohmic resistance not equal zero, thermal effect is produced due to flow of the electric charge of consumed electric energy is directly proportional with square of current intensity

16- Effective value of A.C.: It is the value of the direct current (DC) which generates same rate of thermal effect in a resistance (or same power in same resistance) as that generated by the considered alternating current.(AC)

17- Alternating current: It is a current, which changes periodically its direction and intensity with time according to sinusoidal curve

18- Electric transformer: device to step up or step down an AC voltage It depends on the mutual induction between 2 coils

19- Effeciency of the transformer(η): it is the ratio between the energy gained from the secondary coil to the energy given from the source to the primary coil within the same time

20- Part of electric energy is converted in the iron core into heat energy due to eddy currents To reduce this we made the core of thin insulated sheets of siliconic soft iron having a high resistivity which decreases the eddy currents

21- Assuming that there is no loss in the electric energy or magnetic flux through the transformer, (The transformer is said to be ideal or its efficiency = 100 %), the electric energy made available by the source in the primary coil must equal that delivered to the load in the secondary coil

$$V_p I_p t = V_S I_S t$$

Input Power = Output Power.

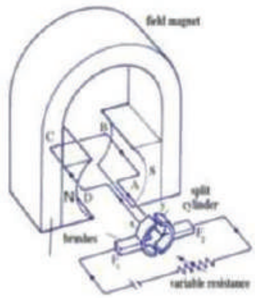
$$V_p I_p = V_S I_S$$

22- Using of the step up electric transformer at electric power stations: As it raises the voltage to a very high value that is associated with small value of current Which decrease losses in the electric energy during power transmission along great distance **(Loses in power equal IR^2) where I is the current intensity pass through wires and R is the resistance of the wires**

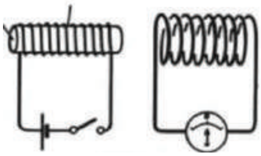
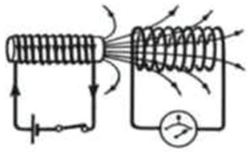
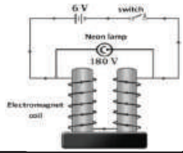
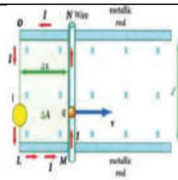
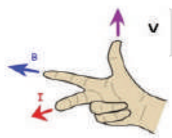
23- the idea of electric motor is the same idea of a moving coil galvanometer the difference between them that **The coil of the electric motor continues rotating in same direction The two halves of the cylinder must interchange position relative to the two brushes each half cycle To make the electric current reverse its direction in the coil each half revolution, so the current direction in the external circuit become unidirectional**

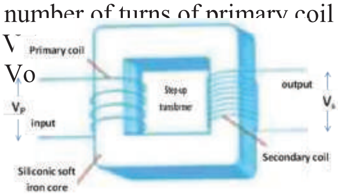
24- Direct current (Dc) motor: It converts the electric energy to mechanical (kinetic) energy

25- To keep constant torque at maximum value many coils separated by small equal angles between their planes are used The two terminals of each coil is connected to the 2 opposite splits of the cylinder The cylinder is split into a number of segments twice that of the number of the coils During the rotation each two opposite segments touch the two brushes when their corresponding coil is in the position of the largest torque



<u>**laws and Mathematical relations**</u>

1-	**Faradays law of electromagnetic induction** $$\mathbf{emf} = -\frac{\mathbf{N\Delta\phi}}{\mathbf{\Delta t}}$$ **ϕ=ABcos θ**	emf: average induced electromotive force $\Delta\phi_m$ it is the change in magnetic flux lines cut through time Δt N is the number of turns of the coil θ = the angle between the normal of the coil plane and the direction of magnetic field
2-	**induced Electromotive force between 2 coils** $$\mathbf{emf_2} = -\mathbf{M}\frac{\mathbf{\Delta I_1}}{\mathbf{\Delta t}}$$ 	emf: average induced emf in the secondary coil M: the coefficient of mutual induction $\frac{\Delta I_1}{\Delta t}$ is the rate of change of current in the primary coil  At the moment of closing the circuit of the primary coil
3-	**induced Electromotive force by self induction** $$\mathbf{emf} = -\mathbf{L}\frac{\mathbf{\Delta I}}{\mathbf{\Delta t}}$$	emf: average induced emf in the coil L: the coefficient of self induction $\frac{\Delta I}{\Delta t}$is the rate of change of current in the coil 
4-	Induced emf in a moving straight wire: $$\mathbf{emf} = \mathbf{B\ell\ v sin\theta}$$ 	ℓ : length of moving wire B: magnetic flux density v: velocity of moving wire θ : the angle between the direction of motion and the magnetic flux lines 

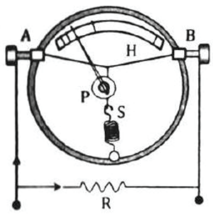
5-	**Instantaneous value of emf induced in dynamo** $$\mathbf{emf = BAN\omega \sin\theta}$$ When the coil is perpendicular to the magnetic flux lines the emf induced is = zero	B: magnetic flux density A: area of the coil N is the number of turns of the coil ω : angular velocity =(2π f) where f is the frequency θ is the angle between the normal to the plane of the coil and the magnetic field lines
6-	**Maximum value of emf induced in dynamo** $$\mathbf{emf = BAN\omega}$$	B: magnetic flux density A: area of the coil N is the number of turns of the coil ω : angular velocity =(2π f) where f is the frequency
7-	Angular velocity $\omega =$ $$2\pi \ x \frac{\text{Number of revolutions}}{\text{time}} = 2\pi \ xf$$	Liner Velocity ($v = \omega$ r) Where (r) is the radius of the coil A =(L) (2r)
8-	**Effective value of induced emf** $$\mathbf{emf_{eff} = 0.707\ emf_{max}}$$	Effective value of induced current $$I_{eff} = 0.707\ I_{max}$$
9-	**The electric transformer** $$\frac{\eta V_P}{V_s} = \frac{I_S}{I_P} = \frac{N_P}{N_S}$$	η efficiency of transformer (in ideal transformer =100%=1) N_s the number of turns of secondary coil N_p the number of turns of primary coil V_s the V V_p the Vo 
10-	**Efficiency of transformer η** $$\eta = \frac{V_S I_S}{V_P I_P}$$	I_s the current pass through secondary coil I_p the current pass through primary coil.

chapter four: AC circuits

Concepts

1- Ac current: current changes its intensity periodically; increasing from zero to maximum value then drops to zero through a half cycle. And then the current direction is reversed, and its intensity goes from zero to maximum and drops back to zero through the other half cycle. This variation is typically repeated each cycle.

2- The hot wire ammeter is connected in series to the circuit. The current to be measured is passes through the instrument. The wire AB gets heated due to the current and expands. Consequently, the tension in the wire decreases. The silk wire stretches the hot wire because of the tension in the spring on the other side, the cylinder rotates a little and the pointer deflects along the scale. The pointer gives a definite reading when the temperature of the platinum – iridium wire becomes constant and the wire stops expanding. That is achieved when the rate of the heat radiated from the wire becomes equal to the rate of the heat generated in the wire. The pointer reading indicates the effective value of AC current.

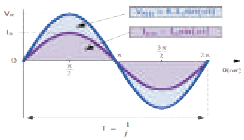


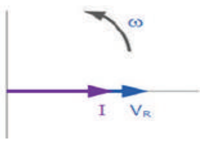
3- Hot wire ammeter is calibrated by connecting it with a moving coil ammeter in series to a direct current circuit. It is essential to notice that the scale of hot wire ammeter is not uniformly divided. The scale divisions for equal increments of current increases as the value of current increases since the heat generated in a wire is directly proportional to the square of the current value passing through it ($Q \propto I^2$)

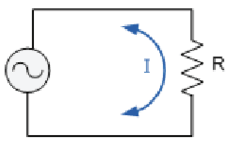
Alternating Current (AC) Circuits

4- AC current and AC voltage in a non-inductive Ohmic resistance: (R)

They can be represented graphically, or represented by two vectors having the same direction where (V) and (I) has the same phase. They grow till reach their maximum values together

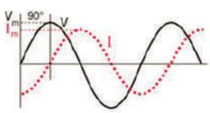


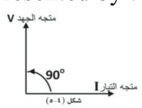


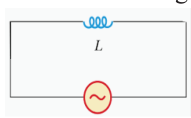


5- AC current and AC voltage in an inductive coil of a negligible ohmic resistance:

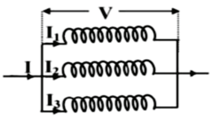
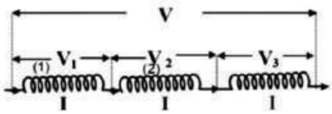
It is obvious that the voltage **leads** the current by a phase angle 90^{o}. Both current and voltage across an inductor can be represented by two vectors as in the figure



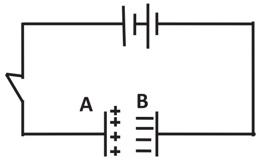




inductive reactance $X_L = 2\pi f L$ **Ohm**
Where f is the frequency of current and L is coefficient of self-induction (henry)
the inductive reactance It is the opposition to the flow of the AC current through a coil due to its self-inductance.
6- The inductive reactance of a group of coils connected together

If the inductors are connected in parallel	**If the inductors are connected in series:**
	
The total current is the summation of the current of each inductor	Current is constant for all inductors
voltage is constant for all inductors	The total voltage is the summation of the voltage of each inductor
$\frac{1}{X_L} = \frac{1}{X_{L1}} + \frac{1}{X_{L2}} + \frac{1}{X_{L3}}$	$X_L = X_{L1} + X_{L2} + X_{L3}$
Equal inductive reactances connected in parrallel $X_L = \frac{X_{L1}}{n}$	Equla reactances connected in series $X_L = nX_{L1}$
The Equivalent inductance $\frac{1}{L} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + \ldots\ldots\ldots\ldots$ For equal inductance $L = \frac{L_1}{n}$ For two inductors $L = \frac{L_1 . L_2}{L_1 + L_2}$	The Equivalent inductance $L = L_1 + L_2 + L_3 + \cdots$ For equal inductance $L = n L_1$

7) AC current and AC voltage in a capacitor circuit.



The electric capacitor: is two parallel metal plates confining an insulator between them. When the capacitor is charged, one plate is positively charged while the other is negatively charged having a potential difference (V) between them. If the quantity of charge on one of its plates is (Q) and the capacitance of the capacitor is (C), the relation between them is given by: $C = \frac{Q}{V}$, where the charge is measured in Coulombs, the voltage in Volts and the capacitance in Farads.

When the capacitor is fully charged, the current through the circuit is zero and the potential difference across the two plates equals the potential difference across the battery therefore the process of the transfer of charges will stop

the capacitive reactance

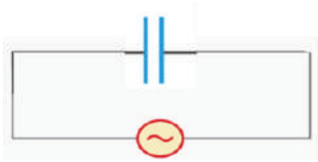
It is the opposition to the flow of AC current in a capacitor due to its capacitance.

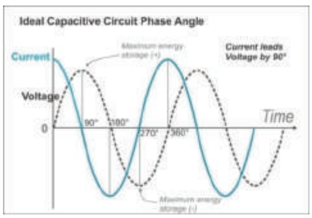
The capacitive reactance in a capacitor (X_C) is given by the relation:

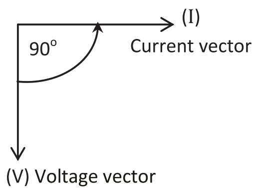
$$X_C = \frac{1}{2\pi f C} \quad \text{Ohm,}$$

Where (f) is the current frequency.

It is obvious that the voltage **lags** the current by a phase angle 90°. Both current and voltage across a capacitor can be represented by two vectors as in figure.

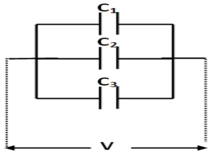
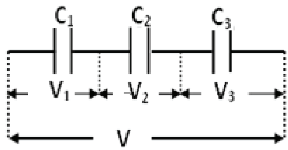






AC voltage lags AC current in a capacitor by 90°

8- capacitive reactance for a number of capacitors

capacitors are connected in parallel	capacitors are connected in series
	
If capacitors are connected in parallel, the voltage across each capacitor is the same: $\mathbf{V = V_1 = V_2 = V_3}$ $\mathbf{Q = Q_1 + Q_2 + Q_3}$	they are charged equally with a charge Q. $\mathbf{Q = Q_1 = Q_2 = Q_3}$ $\mathbf{V = V_1 + V_2 + V_3}$
Equivalent capacitance $\mathbf{C = C_1 + C_2 + C_3}$	Equivalent capacitance $\mathbf{\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}}$
Eqaul capicitors in parrallel $\mathbf{C = n\,C_1}$	Eqaul capicitors in series $\mathbf{C = \frac{C_1}{n}}$
Reciprocal of Equivalent capacitive reactance $\mathbf{X_C}$ in parrallel equal sum of the reciproacal of these reactances $\mathbf{\frac{1}{X_C} = \frac{1}{X_{C1}} + \frac{1}{X_{C2}} + \frac{1}{X_{C3}}}$	Equivalent t capacitive reactance$\mathbf{X_C}$ in series equal sum of these reactances $\mathbf{X_C = X_{C1} + X_{C2} + X_{C3}}$
Eqaul capacitive reactance in parralel $\mathbf{X_C = \frac{X_{C1}}{n}}$	Eqaul capacitive reactance in series $\mathbf{X_C = nX_{C1}}$

9- Impedance:

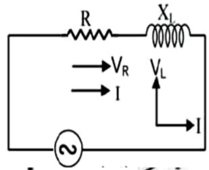
In the electric circuit that contains an AC power supply together with inductive coils, capacitors, and resistors; the AC current is opposed by a reactance in addition to the ohmic resistance.

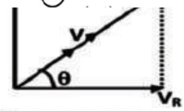
This combined opposition will be a vector combination of resistance and reactance which is known as **impedance,** its symbol is “**Z**”.

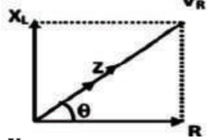
10- AC circuit contains ohmic resistance and inductor in series (RL-circuit)

To find the total voltage across them, phase vectors are used.

That is because the voltage and the current in the resistance are in phase while the voltage in the coil leads the current by a phase angle 90°

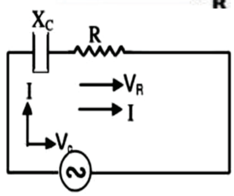






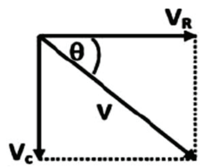
$V = \sqrt{V_R^2 + V_L^2}$	Total voltage V:
$\tan\theta = \frac{V_L}{V_R} = \frac{X_L}{R}$	Phase difference between total current and voltage :
$Z = \sqrt{R^2 + X_L^2}$	The total impedance :

11- AC circuit contains ohmic resistance and capacitor in series (RC-circuit):



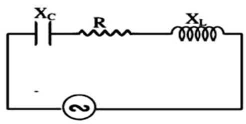
The voltage and the current in the resistance are in phase while the voltage in the capacitor lags the current by a phase angle 90°

The total voltage V can be determined by the relation:

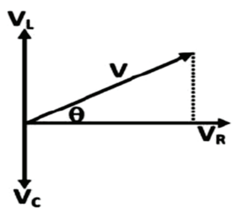


$V = \sqrt{V_R^2 + V_C^2}$	Total voltage V:
$\tan\theta = \frac{-V_C}{V_R} = \frac{-X_C}{R}$	Phase difference between total voltage and current:
$Z = \sqrt{R^2 + X_C^2}$	The total impedance of the circuit :

12- AC circuit contains ohmic resistance, inductor and capacitors in series (LCR-circuit):



The current passing through the resistance, the inductor and the capacitor is the same since they are connected in series while the voltage across each of them differ from the current in phase

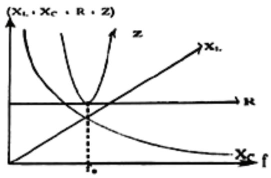


$V = \sqrt{V_R^2 + (V_L - V_C)^2}$	Total voltage V:
$\tan\theta = \frac{V_L - V_C}{V_R} = \frac{X_L - X_C}{R}$	Phase difference between total voltage and current :
$Z = \sqrt{R^2 + (X_L - X_C)^2}$	The total impedance :

13- AC circuit contains ohmic resistance, inductor and capacitor in series

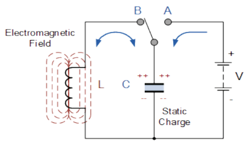
if $X_C = X_L$	if $X_C > X_L$	If $X_C < X_L$
Phase angle = 0	the phase angle is negative	the phase angle is positive
have characteristics of Ohmic resistance.	have capacitive characteristics	have inductive characteristics
the voltage and the current has the same phase	the voltage lags the current by a phase angle θ	the voltage leads the current by a phase angle **θ**

14- The inductive reactance in the coil and the capacitive reactance in the capacitor do not consume any electric power because the energy (power) is stored as a magnetic field in the coil and electric field in the capacitor. The capacitor returns it back to the power supply on discharge. The power consumed in the circuit is that consumed due to the ohmic resistance.

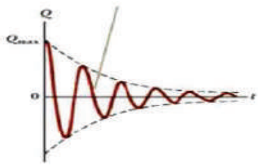


The relation between each of resistance, reactance and impedance and the current frequency

15- Oscillatory circuit exchange of energy stored in the inductive coil in the form of an magnetic field and the capacitor stores energy in the form of an electrostatic field.



16- Electrical energy is lost in the DC or real resistance of the inductors coil, in the dielectric of the capacitor, and in radiation from the circuit so the oscillation steadily decreases until they die away completely and the process stops. However, if this loss is compensated by extra charges supplied to the capacitor, the oscillatory action of passing energy back and forth between the capacitor and the inductor would continue indefinitely.



The diagram illustrates a damping oscillation due to ceasing of charge on capacitor plates over time.

17- Finding the current frequency in the oscillator circuit:

In the oscillator circuit, when capacitive reactance and inductive reactance are equal and cancel out each other, leaving only the resistance of the circuit to oppose the flow of current, the current reaches its maximum in the circuit. The circuit frequency can be deduced as follows:

$\because \quad X_L = X_C$ $\qquad \therefore 2\pi f L = \frac{1}{2\pi f C}$

The circuit frequency: $f = \frac{1}{2\pi\sqrt{LC}}$

We can substitute self-inductance **L** by the relation

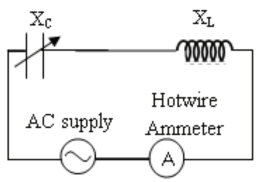
$$L = \frac{\mu A N^2}{l}$$

18- Tuned or "Resonant" Circuit

It is an electric circuit consisting of a capacitor of variable capacitance connected to an inductor whose inductance can be altered.

The most common application of resonant circuits is **tuning** radio receivers for picking out the signal of a particular station, at a particular frequency.

Operation of resonant circuit: Connect a circuit of an AC power supply of varying frequency, a capacitor of variable capacitance, an inductor and hot wire ammeter as shown in the figure



Tuned circuit

The laws and mathematical relations

	The physical quantity	The law
1	inductive reactance	$X_L = 2\pi f L$
2	inductive reactance for capacitors connected in series	$X_{Lt} = X_{L1} + X_{L2} + X_{L3} + \cdots$
3	inductive reactance for capacitors connected in parallel	$\frac{1}{X_{Lt}} = \frac{1}{X_{L1}} + \frac{1}{X_{L2}} + \frac{1}{X_{L3}} + \cdots$
4	Capacitive reactance	$X_C = \frac{1}{2\pi f C}$
5	Equivalent capacitance for capacitors connected in series	$\frac{1}{C} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \cdots$
6	Equivalent capacitance for capacitors connected in parallel	$C = C_1 + C_2 + C_3 + \cdots$
7	Impedance	$Z = \sqrt{R^2 + (X_L - X_C)^2}$
8	Total voltage	$V = \sqrt{V_R^2 + (V_L - V_C)^2}$
9	Phase angle between voltage and current	$\tan\theta = \frac{V_L - V_C}{V_R} = \frac{X_L - X_C}{R}$
10	$V_R = IR$ $V_L = IX_L$	$V_C = IX_C$ $V_T = IZ$
11	Resonance frequency	$f = \frac{1}{2\pi\sqrt{LC}}$
12	Power dissipated in a circuit	$P_w = I^2 R$

Unit two: introduction to modern physics

Chapter Five: wave particle duality

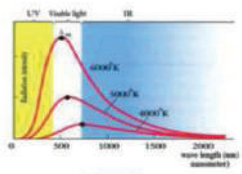
Concepts

1- **classical physics cannot explain many phenomena, particularly those in which light or em radiation interacts with electrons or atoms**

2- **light or any em radiation consists of a huge collection of photons, each photon having energy hv where h is Planck's constant and v is the frequency**

Electromagnetic spectrum

3- **The distribution of the radiation intensity produced from hot (glowing) body with wavelength is called Planck's distribution, and this radiation is called black body radiation It also found that the wavelength λ_m at which the peak of the curve is inversely proportional to temperature. this known as Wien's law . we also note that as the wavelength tends to infinity (very large) or to zero (very small) the intensity of radiation tends to zero**



The wavelength at the peak is inversely proportional to temperature

4- **Classical physics: since the radiation is an em wave, the intensity of radiation increase with frequency**

5- **Modern physics: the curve is repeated for all hot bodies which emit continuous radiation not only the sun but also the earth and all bodies even living creatures but the earth being a non glowing body it absorbs the radiation from the sun and reemits it but the temperature is far less than that of the sun so we find the wavelength at the peak is within the infrared region.**

6- **A black body is perfect absorber, and perfect emitter**

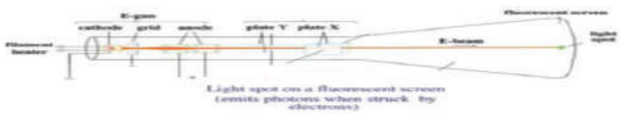
7- Radiation is made up of concentrated package of energy called Quantum or photon. Therefore the radiation emitted from hot bodies is made up of a huge stream of photons emitted from hot body, As the frequency of the photon increases, its energy increases **But** the number of emitted photons decreases with increasing energy, So, the radiation intensity decreases, photons emitted by vibrating atoms

8- the energy levels take values ($E = nh\upsilon$), where (h) is Planck's constant

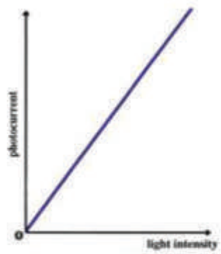
$h = 6.625 \times 10^{-34}$ j.s and ν is the frequency (Hz)

The atom does not radiate as it remains in one energy level but if the vibrating atom shifts from a high energy level to a lower energy level, atom emits a photon of energy ($E = h\upsilon$).

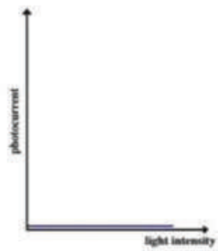
9- Photoelectric effect and thermionic effect: a metal contains positive ions and free electrons which can move around inside the metal but cannot leave it, due to the attractive forces of the surface which may be represented by surface potential barrier. but some of these electrons can escape if given enough energy in the form of heat or light this is the idea behind the cathode ray tube (CRT) which is used in TV and computer monitors. The photocell converts the light energy into electric energy



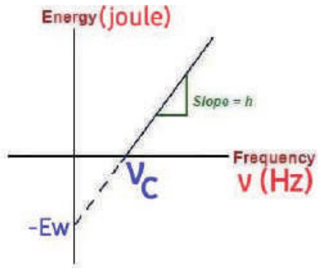
10- the evidence for photons is the photoelectric effect where photocurrent depends on the intensity of incident light as long as the frequency is greater than a critical value ν_c. But if the frequency is less than ν_c no photocurrent flows. the kinetic energy of the electron freed by the photoelectric effect depends on the frequency not on the light intensity



Photocurrent versus light intensity for $\nu > \nu_c$



Photocurrent versus light intensity for $\nu < \nu_c$



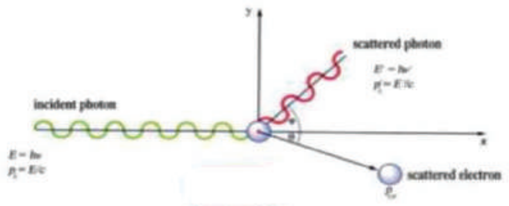
11- the work function(E_w) depends on the type of the metal and it is the minimum energy needed to free an electron from its parent atom.($E_w = h\nu_c$)

12- It is to be noted that υ_c and E_w: Vary for different materials. Do not depend on the light intensity.- Do not depend on the exposure time- Do not depend on the potential difference between the anode and the cathode

13- Einstein equation for Photoelectric effect : $K.E = \frac{1}{2} mv^2 = h\nu - h\nu_c$

14- A photon has a mass, a linear momentum and a constant speed which is the speed of light. it has a size denoted by the wavelength if a photon falls on a wall it applies a small force on it, but if it falls on an electron the electron will be thrown off due to its small mass and size

15- Compton effect proves the particle nature of photons where a photon has mass speed and linear momentum When a photon (X or γ rays) collided with a free electron at rest, the photon frequency decreased and changed its direction. Also, the electron velocity increased and it changed its direction (the energy of photon + energy of electron) before collision = (the energy of photon + energy of electron) after collision



Compton effect

16- the wave describes the collective behavior of photons

17- Einstein showed that mass and energy were equivalent $E = mc^2$. A loss of mass is converted to release energy as in atomic bomb

18- Each photon incident on the surface and bounces off suffers a change in linear momentum the force which a beam of photons applies to the surface is the change in linear momentum per second

$$F=2mc\phi_L$$

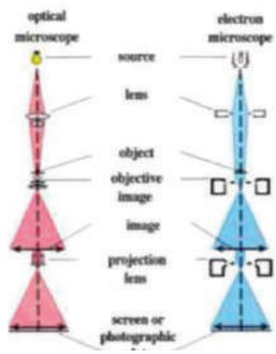
$$\mathbf{F} = 2\left(\frac{\mathbf{h\nu}}{\mathbf{c}}\right)\boldsymbol{\Phi}_{\mathbf{L}} = \frac{\mathbf{2P_w}}{\mathbf{c}}$$

where the P_w is the power in watt of the light incident on the surface

19- The wavelength of photon equal to plank's constant divided by the liner momentum (P_L) the same relation applied on moving particle where The wavelength in this case describe wave associating particle motion

$$\lambda = \frac{h}{P_L}$$

20- when a photon fall on a surface comparison is made between λ and the inter atomic distance of the surface, if Light ray has (λ) greater than the inter atomic distance; these photons sense the surface as a continuous one and get reflected from it as in wave theory. if the inter atomic distance comparable to λ , photons penetrate through the atoms, as in case of X-rays



21- the electron microscope proves de Broglie relation for Particles it is used to detect diminutive particles

22- electron microscope is an important lab instrument which depends in its operation on the wave nature of electrons, the velocity of the free electron can be calculated by the relation

$$eV = \frac{1}{2}mv^2$$

23- In the optical microscope the ligtht ray is used while In the electron microscope the electron beam is used

The laws and mathematical relations

Law	physical Quantity	No.
$E = h\nu = h\frac{C}{\lambda}$	**Photon's energy**	**1**
$C = \lambda\nu$	**Speed of photon**	**2**
$\lambda_1 T_1 = T_2 \lambda_2$ or $\frac{\lambda_{m1}}{\lambda_{m2}} = \frac{T_2(K)}{T_1(K)}$	**Wien's law**	**3**
$E_w = h\nu_c = h\frac{C}{\lambda_c}$	**Work function**	**4**
$K.E. = E_{photon} - E_w$ $\frac{1}{2}mv^2 = h\nu - h\nu_c$	**Photoelectric effect**	**5**
$E = mc^2$	**Einstein relation**	**6**
$m = \frac{E}{C^2} = \frac{h\nu}{C^2} = \frac{h}{C\lambda}$	**Mass of photon**	**7**
$P_L = mC = \frac{E}{C} = \frac{h\nu}{C} = \frac{h}{\lambda}$	**Liner momentum of photon**	**8**
$F = 2mC\phi_L = 2\frac{h\nu}{C}\phi_L = \frac{2P_w}{C}$	**Force of beam of photons affect on surface**	**9**
$P_w = E\phi_L = \frac{EN}{t}$	**The Power of light beam** **ϕ_L: rate of photons** **N:number of photons** **t: time (sec)**	**10**
$\lambda = \frac{h}{P_L} = \frac{h}{mv}$ (De Broglie equation)	**Wavelength associate particle motion**	**11**
$(E_{photon}+E_{electron})_{before\ collision} = (E_{photon}+E_{electron})_{after\ collision}$ $(P_{L\ photon}+P_{L\ electron})_{before} = (P_{L\ photon}+P_{L\ electron})_{afte}$	**Compton effect**	**12**
$K.E. = \frac{1}{2}mv^2 = eV$	**Kinetic energy of an electron**	**13**

Chapter six: atomic spectra

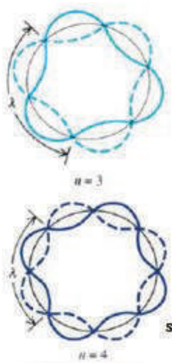
From Bohr's assumptions

1- If an electron moves from an outer energy level (higher energy level) of energy E_2 to an internal energy level(lower energy level) of energy E_1 (where $E_1 < E_2$), energy is released in the form of a photon of frequency ν

$$\Delta E = h\nu = \frac{hc}{\lambda} = E_2 - E_1$$

2- We can estimate the radius of the orbit by considering that the wave accompanying the electron forms a standing wave ($n\lambda = 2\pi r$) (r : radius of the orbit)

Where n is number of the energy level and λ is the wavelength associated with the movement of the electron



standing waves

3- The linear spectrum of the hydrogen atom consists of five groups or series of spectral lines, each line corresponding to a specific energy, and therefore a specific frequency and wavelength.

Lyman Series	UV region	when the electron moves from higher energy levels to K (n = 1)
Balmer Series	Visible light region	when the electron moves from higher energy levels to L (n = 2)
Paschen Series	Near IR region	when the electron moves from higher energy levels to M (n = 3)
Brackett Series	middle IR region	when the electron moves from higher energy levels to N (n = 4)
Pfund series	far IR region	when the electron moves from higher energy levels to O (n = 5)

4- The energy of level in hydrogen atom can be calculated from the following relation

$$E_n = \frac{-13.6\ \text{ev}}{n^2} = \frac{21.76 \times 10^{-19}\text{J}}{n^2}$$

Where n represents the number of the level

To calculate the shortest wavelength in any series

$$\lambda = \frac{h\,c}{E_\infty - E_n}$$

To calculate the longest wavelength in any series

$$\lambda = \frac{h\,c}{E_{n+1} - E_n}$$

5- Spectrometer: It is used to obtain a pure spectrum, as it is used to analyze light into its components (visible and invisible).
6- By studying the spectra of different substances whose atoms are in an excited state, we note that:

Continuous spectrum: the spectrum that contains all possible wavelengths in continuous manner and includes a continuous distribution of frequencies that is a band spectrum

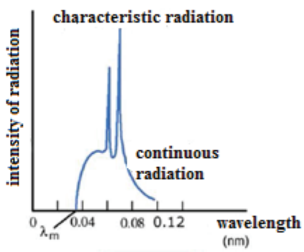
Line spectrum: the spectrum that contains a discrete distribution of frequencies or wavelengths

Line emission spectrum: It is the spectrum produced by the transition of excited atom from a higher level to a lower one

The Fraunhofer lines

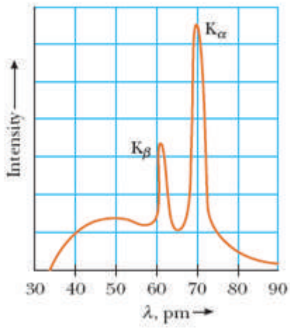
1) It is **the dark lines in sunlight** continuous spectra
2) **Fraunhofer lines** in the solar spectrum are examples of the absorption line spectra of the elements in the sun as **helium and hydrogen**

7- **X ray: can be obtained by using Coolidge tube**
8- By analyzing a beam of X- rays generated from target to components of different wavelengths, **we find that the spectrum consists of two parts**:
a) **The continuous spectrum** of all wavelengths that does not change with changing the target material and depends on the potential difference between the filament and the target material. The minimum wavelength (maximum frequency) can be obtained from the relation



$$\lambda_{min} = \frac{hc}{eV} \qquad eV = h\nu_{max}$$

b) **The line spectrum corresponding to specific wavelength** characteristic of the target material called the characteristic x – rays radiation that does not depend on the potential difference between the filament and the target material. The higher the atomic number of the target material, the smaller the characteristic wavelength of the target material.



The wavelength of the characteristic spectrum can be calculated from the relation

$$\Delta E = \frac{hc}{\lambda} = h\nu_{max}$$

9- The intensity of the X-rays depends on the intensity of the electric current passing through the filament, the intensity of the X-rays increases with increasing intensity of the electric current passing through the filament

10- X-ray diffraction is used to study the crystalline structure of solids

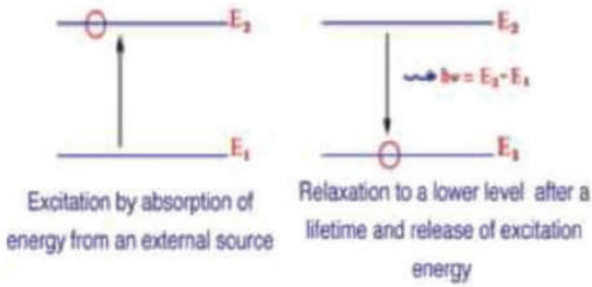
11- X-rays have the ability to penetrate through material media, so X-rays are used to detect defect in metallic structure

Chapter Seven: LASER

Concepts

LASER: means light amplification by stimulated emission of radiation

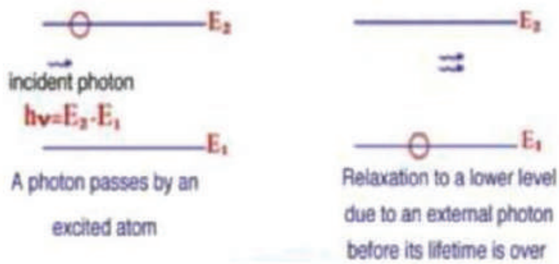
1- **Spontaneous emission: it is the** emission of photon from one excited atom as it relaxes from a high energy level to a low energy level after the lifetime interval is over spontaneously without any external factor



Spontaneous emission

- The emitted photons propagate randomly in all directions
- The intensity of photons decreases according to the inverse square law. This is called spreading. While collision with particles is called scattering
- This is the dominant radiation in ordinary light sources such as electric lamp

2- **Stimulated emission: it is the** Emission of photon from the excited atom as a result of collision with an external photon, which has the same energy as the one that caused it to be excited before the lifetime interval is over. photons at the end come out in coherence (i.e. having the same phase , (direction and frequency)



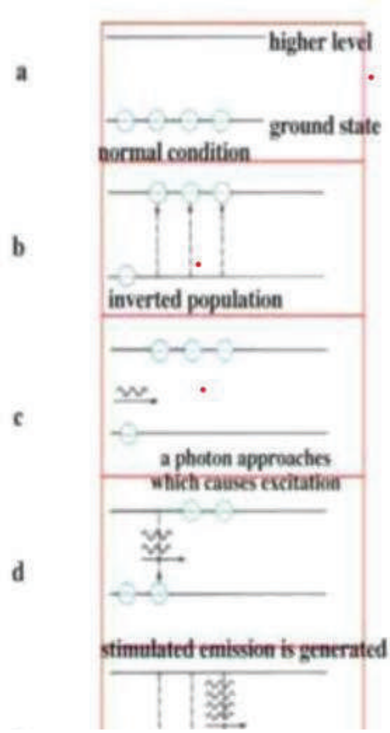
Stimulated emission

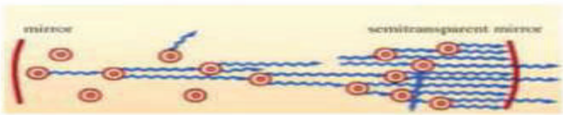
- The emitted photons have single wavelength.(monochromatic)
- The emitted photons propagate in same phase (coherent),and propagate in one direction forming a narrow parallel beam. (Collimated parallel beam.)
- The intensity remains constant over long distances contrary to the inverse square law. Spreading effect is nil and limited scattering takes place.
- This is the dominant radiation in laser sources

3- **<u>properties of laser beam</u>**
   a) spectral purity (monochromatic)
   b) collimation (parallel rays)
   c) coherence (same phase and direction)
   d) concentration (high intensity)
4- Laser beam transmitted for long distances without much loss in energy: as they are highly collimated so the diameter stays constant for long distances without much scattering. Thus, energy is transmitted without much loss.

- **<u>Theory of laser action:</u>**

a) the active medium must in the state of population inversion
b) emission of radiation for the excited atom through the stimulated emission
c) amplification of stimulated emission through the resonant cavity

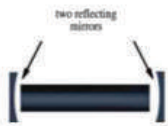




Multiple reflections between the two mirrors

Amplification by multiple reflections

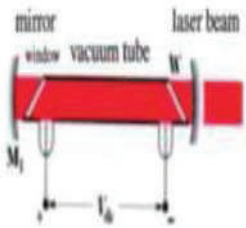
5- **<u>main components of a laser:</u>**
   a) an active medium
   b) a source of energy (Pumping)
   c) a resonant cavity

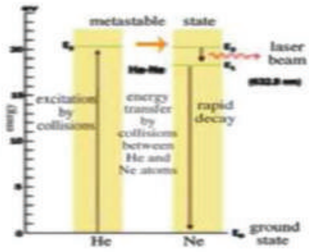


External resonant cavity

Internal resonant cavity

6- Helium – Neon (He – Ne) laser: these two elements have been selected due to the near equality of the values of the same metastable excited energy levels in these two elements
   a) laser device including a mixture of helium and neon in the ratio 10 :1 at low pressure of nearly 0.6 mmHg
   b) high voltage difference inside the tube causing electric discharge leads to the excitation of the helium atoms to higher level,





He – Ne laser energy levels

c) the energy transferred from the excited heluim atoms to the neon atoms due to their collision.

d) an accumulation of excited neon atoms in an excited level has relatively long lifetime (nearly 10^{-3} s) called metastabel state so population inversion occurs in neon atoms

e) The presence of an opaque mirror and another partially transparent mirror in the ends of the He-Ne laser cylindrical tube: Acts as a reflector for the beam of photons till the beam becomes sufficiently intense (amplified); part of it emerges through the semi-transparent mirror in the tube.

7- Some applications

a) laser beam used in treatment of retenal detachment in eye
b) laser beam used in Precision guidance
c) laser beam in communication: Where optical fibers carry information - loaded laser beam instead of a wire carrying electrical signals

8- **Holography (3D imaging): object images formed by collecting light rays that leave the lighting object surface carrying information from it until the image is formed due to the difference in phase and intensity from one point to another**

a) Hologram: coded image resulting from interferance fringes from interferance of refrance beam and reflected beam from object
b) **Reference beam** It is laser beam reflected from the mirror has the same wavelength as the reflected beam from object they meet and interfere at the photographic plate to get the missed information of the image,. (Constructive and destructive interference)
c) We cannot obtain a 3D image unless using laser beam : to obtain 3D image you should use photons have same phase (coherent) to show the difference in phase and intensity during interference

Rules:

Law	Physical quantity
$phase\ difference = \frac{2\pi}{\lambda}\ X\ path\ difference$	**Phase difference in terms of path difference**

Chapter eight: modern electronics

Concepts

Pure semiconductor

1- A pure (semiconductor) silicon crystal consists of atoms linked by covalent bonds.
2- At very low temperature, pure silicon crystal behaves as an insulator and **at 0Kno free electrons**(because all bonds in the crystal are unbroken) **(at 0K, Silicon behaves as a prefect insulator)therefore the electric conductivity = zero**
3- By increasing the temperature some of the covalent bonds are broken and some of the electrons are freed (negative charge carriers) .When the electron is freed, it leaves behind a vacancy in the broken bond **(**This vacancy is called a **hole) (**positive charge carriers)**.**
4- As the temperature increases, the number of free electrons and holes increases, where the number of free electrons equals the number of free holes in a pure semiconductor. If the temperature increases above certain limit state of dynamic equilibrium takes place (called **thermal equilibrium**) (The number of bonds broken per second will be equal to the number of bonds mended per second)a small percentage of bonds are broken, so that a fixed number of free electrons and free holes remains constant at every temperature
5- To distinguish between semiconductors and conductors.
a) In semiconductors, the number of free electrons and the number of holes increases with the increase in temperature. As for conductors, the number of free electrons is fixed and does not change with the charge carrier change in temperature.
b) The conductivity of conductors increases with decreasing temperature, while the conductivity of semiconductors increases with increasing temperature.
c) Conductors have one charge carrier, electrons, while semiconductors contain two charge carriers, electrons and holes.

Impure semiconductor

The electrical conductivity of the semiconductor is increased by adding a percentage of impurity atoms to the crystal of the pure semiconductor (such as boron, aluminum and gallium, which are trivalent, as well as such as arsenic, phosphorous and antimony, which are pentavalent).

1) The number of free electrons will be more than the holes by adding pentavalent impurities as in the N type
2) The number of holes will be more than the free electrons by adding trivalent impurities as in the P type
3) The semiconductors from which most devices are made are sensitive to the surrounding medium, such as:

- Light
- Heat.
- Pressure.
- Atomic pollution.
- Chemical pollution.

<u>Law of mass action</u>

$$\mathbf{np = n_i^2}$$

Where n_i is the concentration of electrons or holes in a pure semiconductor crystal.

<u>In the case of P type</u>

$$p = N_A^-$$
$$n = \frac{n_i^2}{N_A^-}$$

N_A^-: Concentration of impurity atoms

<u>In the case of N-type</u>

$$n = N_D^+$$
$$p = \frac{n_i^2}{N_D^+}$$

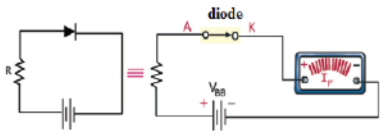
N_D^+: Concentration of impurity atom

<u>PN junction (Diode)</u>

1- A **PN junction** is formed from to regions P region has a high concentration of holes and N region contains high concentration of electrons.

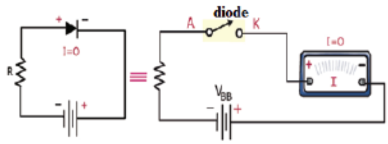
2- Forward Connection (forward bias)

PN junction connected to an external voltage where the p-type is connected to the positive terminal and the n-type is connected to the negative terminal of a battery



3- reverse Connection (reverse bias)

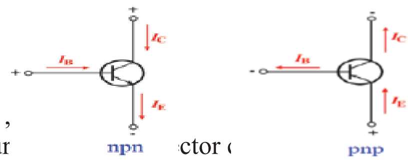
PN junction connected to an external voltage where the N-type is connected to the positive terminal and the P-type is connected to the negative terminal of a battery



4- The diode is used to rectify alternating current

<u>Transistor</u>

1- A transistor is classified into npn or pnp



2- The transistor is used for amplification , switch ,

ctor (

3- The relation between emitter current I_E, base cur determined from the relation

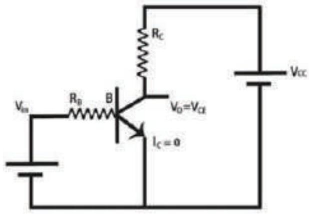
4- $\mathbf{I_E = I_C + I_B}$, $\mathbf{I_C = \alpha_e I_E}$

Current gain β is determined by the relation

$$\boldsymbol{\beta = \frac{I_C}{I_B} = \frac{\alpha_e\ I_E}{(1-\ \alpha_e\ )I_E} = \frac{\alpha_e}{1-\ \alpha_e}}$$

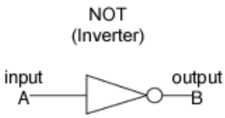
<u>Transistor as a switch</u>

$$V_{CC} = V_{CE} + I_C R_C$$



الترانزستور npn كمفتاح في حالة الغلق On

V_{CC}: collector circuit voltage
V_{CE}: the potential difference between the collector and emitter
R_C: collector resistance (load)
I_C: collector current
Logic gates: They are electronic circuits that perform logic operations and depend on Boolean algebra, the basis of digital electronics, such as the NOT gate, the AND gate, and the OR gate.

<table>
<tr><th>Not gate</th><th>OR gate</th><th>AND gate</th></tr>
<tr><td>only one input and one output</td><td>two inputs or more and has one output</td><td>two inputs or more and has one output</td></tr>
<tr><td>a low-voltage input (0) is converted to a high-voltage output (1)</td><td>Produces an output of 1(high) if either or both of the inputs are a 1</td><td>Produces an output of 1(high) when BOTH the inputs are a 1(high), otherwise the output is 0(low).</td></tr>
<tr><td>

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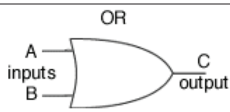
<td>

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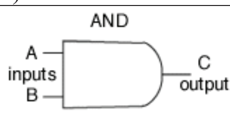
<td>

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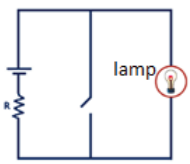
<tr><td>
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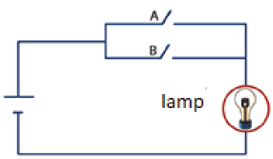
<td>
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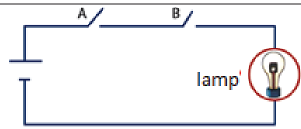
<td>
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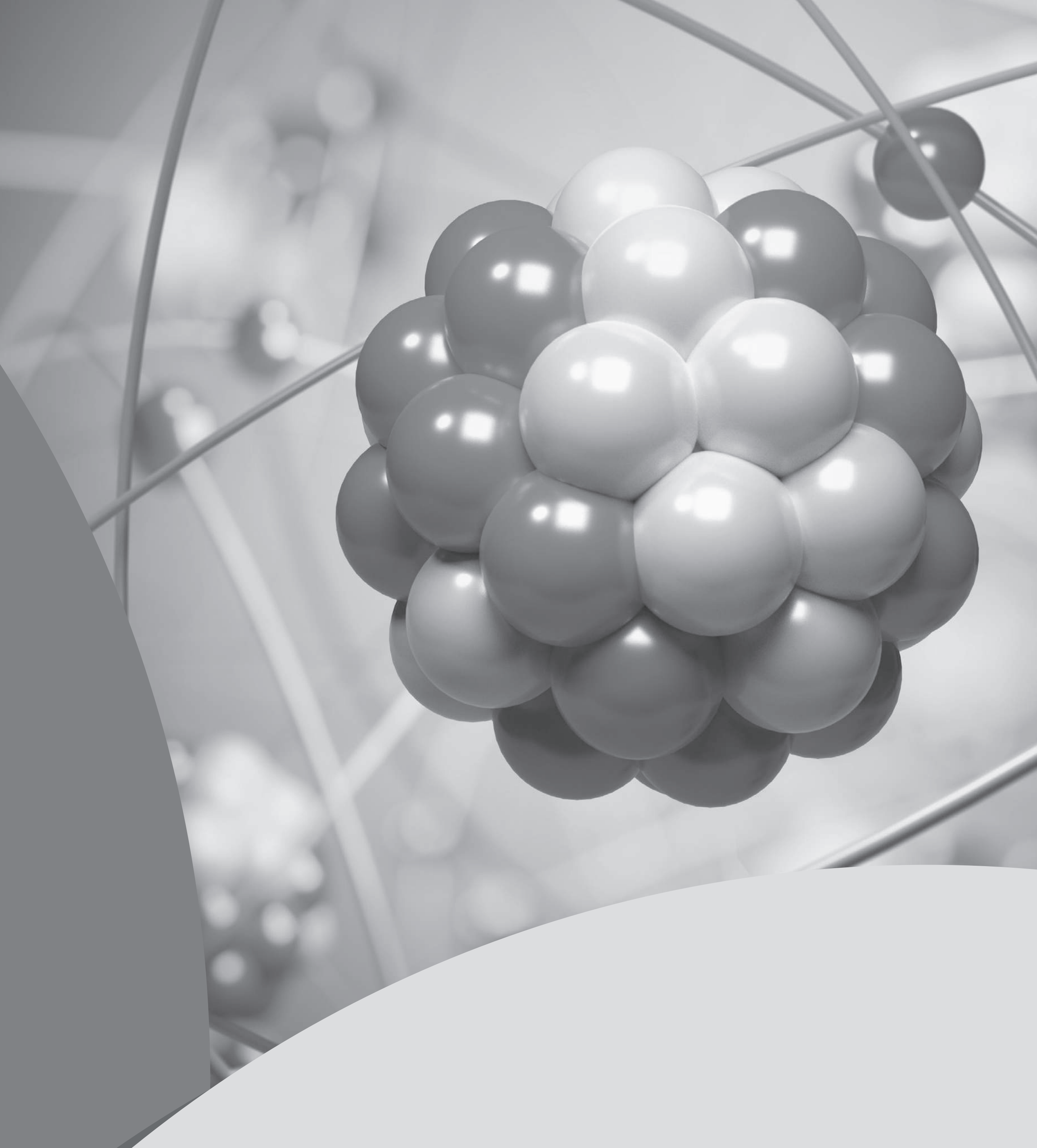
Physical Constants

Physical quantities	Symbol	Value
Magnetic Permeability of air	**μ**	**4π X10^{-7} wb/A.m**
Speed of Light in Vacuum	**C**	**3 X 10^{8} m/sec**
Planck's constant	**h**	**6.625 X10^{-34} J /Hz**
mass of electron	**m_e**	**9.1 X10^{-31} kg**
charge of electron	**e**	**1. 6 x 10^{-19}C**

Prefixes

Power of 10	name
10^{-12}	Pico
10^{-9}	Nano
10^{-6}	Micro
10^{-3}	Milli
10^{-2}	Centi
10^{-1}	Deci
10^{3}	Kilo
10^{6}	Mega
10^{9}	Giga

1 ev = 1.6x10^{-19} J 1 KHz = 10^{3} Hz 1 MHz = 10^{6} Hz 1 GHz = 10^{9} Hz	1 A° = 10^{-10} m 1 cm = 10^{-2} m 1 mm = 10^{-3} m 1 μm = 10^{-6} m 1 nm = 10^{-9} m 1 pm = 10^{-12} m T(K) = t(°C) + 273



مفاهيم الفيزياء (فرنسي)

الصف الثالث الثانوي